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ABSTRACT

An educational program has been developed in the field of information science that emphasizes the design of information storage and retrieval systems for the acquisition, processing, control, and dissemination of documents. The program leads to a Master's Degree in Information Science at the University of California. Systems analysis plays a central role as the methodology of the program. This report reviews the array of contexts within which information science could be taught and then provides detailed information on the aims and content of the five basic information science courses in the program. The report also discusses the overall objectives of the program; the procedures by which students are helped to achieve these objectives, including the role of courses in other departments; the use of information science courses by non-library students; and the role of the thesis. (Author/JY)

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EDUCATION FOR INFORMATION SCIENCE (DOCUMENTATION)

H. Borko and R. M. Hayes

Number 3 of a Series of Reports on

Education for Information Science

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NLM Grant 119

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ABSTRACT

This report describes an educational program in the information sciences that emphasizes the design of information storage and retrieval systems for the acquisition, processing, control and dissemination of documents. Four different orientations to information science education are reviewed. The orientation and the courses of study leading to the Master's Degree in Information Science (Documentation) at the University of California, Los Angeles are presented in detail.

1. INTRODUCTION

The previous reports in this series of Institute publications provided a broad overview of the structure and content of the information science program offered at the UCLA School of Library Service and some precise definitions of INFORMATION, INFORMATION SYSTEMS, and INFORMATION SCIENCE.[1,2] These reports stressed that the teaching of information science cannot be separated from the specific type of information system under investigation, from the methodology used in studying the information producing processes, and from the embedding context or program orientation. In the MSIS program, the type of information studied is recorded data (books, documents, magnetic tapes, etc.); the method employed is that of data processing systems analysis; and the context is the library and information center.

This report reviews the array of contexts within which information science could be taught [Section 2] and then provides detailed information on the aims and content of the five basic information science courses so as to illustrate the central role of systems analysis as the methodology of the program. The courses offered by the School of Library Service are:

- LS 404 - INTRODUCTION TO INFORMATION SCIENCE
- LS 440 - DATA PROCESSING IN THE LIBRARY
- LS 242 - INFORMATION RETRIEVAL SYSTEMS
- LS 240 - INFORMATION SYSTEMS ANALYSIS AND DESIGN
- LS 249 - SEMINAR IN INFORMATION SCIENCE

Obviously these are not the only courses that the student takes. Students are advised to take courses in other departments which will provide the necessary background in statistics, operations research, managerial accounting, and computer programming. In addition, most students elect to take the following specialized courses in information science:

LS 481 - INFORMATION CENTERS

LS 241 - MANAGEMENT INFORMATION SYSTEMS

LS 243 - DATA BASE SYSTEMS

and in their final two quarters, all students must take:

LS 596 - DIRECTED RESEARCH

LS 598 - THESIS PREPARATION

Nevertheless, it is the first group of courses that are the heart of the curriculum and these will be used to illuminate the character and orientation of the program. These are described in Section 3.

The fourth and final section of the report reviews the overall objectives of the program and the procedures by which students are helped to achieve these objectives including the role of courses in other departments, the use of the MSIS courses by non-library school students, and the role of the thesis.

2. DIFFERENT ORIENTATIONS TO INFORMATION SCIENCE EDUCATION

Many universities and colleges throughout this country and the world are now teaching courses in information science. These programs vary. The orientation chosen depending upon the context and emphasis desired. At least four different approaches to the organization of the information science curriculum can be identified.

The theoretically oriented curriculum is based upon the premise that information science is a distinct discipline with its own methodology and research interest. Schools having this orientation emphasize theoretical courses drawn from the formal disciplines of mathematics, logic, and perhaps linguistics. Courses in computer hardware, compiler construction, and data base management systems are also included. The emphasis of the entire program is on theory, methodology, and research.

The computer science oriented curriculum places primary emphasis on the computer. Such programs are generally located in engineering schools and the course of study stresses the mathematics and logic involved in computer hardware and software design. Applications are also a topic of study, but these too emphasize engineering and mathematics, as in the use of computers to design hardware components, to represent recursive functions, etc. Other applications that might be included are linguistics, information retrieval, neuroanatomy, public health, etc.

The library oriented curriculum tends to identify information science with documentation, and these programs are usually located in the Library School. The emphasis is on the use of computers in libraries and the course of study includes library automation, circulation control, on-line cataloging, etc. Also included are courses in information retrieval and dissemination, automatic indexing and abstracting, and the automation of other library processes.

The systems oriented curriculum emphasizes the methodology of systems analysis as it applies in one or more institutional contexts. The curriculum deals with the design and analysis of information systems, information retrieval, library networks, etc. The emphasis is

is on the management and decision-making aspects of information systems rather than on the operational and service needs.

The Master's of Science degree in Information Science (Documentation), which is granted by the School of Library Service at UCLA, is based upon systems oriented curricula. The specialized information courses emphasize the tools and procedures applicable for managing information and the responsibilities involved.

The graduate of a systems oriented curriculum should be prepared to assume a degree of independent responsibility for analyzing the information system of a library, a governmental organization, or a company. He should therefore be able to work, either alone or as a member of a team, on the usual succession of tasks in system development: determining requirements, analyzing present operations, specifying and evaluating alternatives, establishing schedules for development and implementation, and monitoring progress. A typical position for a graduate of a system-oriented program would be "library systems analyst" or "information systems analyst".

3. SYSTEMS COURSES

During his first quarter of school, the student receives intensive counseling. His vocational goals are discussed and clarified. The degree requirements are explained and a course of study planned individually for each student. In addition to the required information science courses, the student rounds out his curricula with courses in computer science and programming, mathematics and statistics, librarian-ship, accounting, education, psychology, logic, etc.

UCLA is on a quarter system; this means that the academic year is divided into four quarters of approximately ten weeks each plus a week for registration, a week for final examinations, and a week of vacation. Although the number of class contact hours can vary with the different courses, for planning purposes twenty class periods are used.

Typically, a student begins his MSIS studies with a series of introductory courses in librarianship (LS 400), bibliography (LS 402) and information science (LS 404). These courses are usually taken during his first quarter in residence.

3.1 LS-404 INTRODUCTION TO INFORMATION SCIENCE,

3.1.1 Purpose:

The purpose of this course is to establish a context within which the student can evaluate the significance of mechanized techniques for library operations and information services. A corollary purpose is to introduce the student to methods of system design and evaluation and acquaint the student with the characteristics of equipment.

3.1.2 Scope and Content:

The following is an outline of the topics covered each week:

Weeks 1 and 2:	Historical review of mechanization in libraries, library networks, and information centers.
Weeks 3, 4, and 5:	Methods of systems analysis, design, and evaluation.

Weeks 6, 7, and 8: Data Processing Equipment, its characteristics and uses.

Weeks 9 and 10: The Use of Computers in Information Processing.

3.1.3 Methods of Instruction

Instruction consists of lectures, discussion in smaller sections, question-answer dialogue. The preparation of an assigned term paper is intended to encourage independent thought and evaluation of the relation between the course content and librarianship.

3.1.4 Methods of Evaluation:

Students are evaluated on the basis of their participation in classroom discussion and on the quality, organization, and richness of thought displayed in the assigned term paper. There may or may not be examinations.

3.2 LS-440 DATA PROCESSING IN THE LIBRARY

3.2.1 Purpose:

The purpose of this course is to provide the student with an understanding of computers and their application to library clerical tasks in sufficient details for him to participate in specific situations with which he may be faced.

3.2.2 Scope and Content:

Three things are covered in the course, more or less in parallel:

1. A review of the current state-of-the-art in the use of the computer on clerical tasks in the library.

2. Experience in the use of methods of systems analysis, design, and evaluation.
3. Experience in programming a computer on relatively simple data processing tasks.

3.2.3 Methods of Instruction:

Instruction consists of lectures covering computer applications, field work in a library (applying the methods of systems analysis), and a computer programming laboratory.

3.2.4 Methods of Evaluation:

Students are evaluated on their participation in classroom discussion, on the quality of their work done in systems analysis, and on their ability to produce an operating computer program.

3.3 LS 242 INFORMATION RETRIEVAL SYSTEMS

The aim of this course is to provide a basis for understanding of mechanized information storage and retrieval systems. The course emphasizes the operational characteristics, the equipment, and the techniques used in document retrieval systems. The course content is divided into six sections:

1) Introduction;
2) Input subsystems;
3) Storage subsystems;
4) Search and retrieval subsystems;
5) Evaluation; and
6) Summing up.

The textbooks used are:

1) Kent, Allen. Textbook on Mechanized Information Retrieval, 2nd Edition, Interscience Publishers, New York, 1966.

2) Lancaster, F. W., Information Retrieval Systems: Characteristics, Testing and Evaluation. John Wiley and Sons, Inc., New York, 1968.

The students are also required to take an essay type mid-term examination and write a term paper in which they analyze a particular piece of equipment, or a procedure, used in an information storage and retrieval system discussing its application, advantages and disadvantages.

3.3.1 Introduction

Class discussion begins with an examination of the problems mankind is experiencing in storing large quantities of information so that it can be found when needed, and the role of modern computer technology in processing textual material and disseminating the results. The different information policies on both the United States and the Soviet Union are sketched and compared.

An information system is defined and the elements, or functional components, of the systems are illustrated by means of a block diagram. This model is used as a device for integrating the course content. In the subsequent discussion of the components of an information retrieval system, reference is made to the model so that the interrelationships can be more easily visualized and understood.

3.3.2 Input Sub-System

Selection, acquisition and analysis make up the input sub-system. The selection policy specifies the kinds of materials to be acquired and the budget available to do so. The basis for formulating a selection policy is discussed as well as its general content. Methods of book acquisition are described briefly with special reference to the availability of pre-processing services at the time of purchase.

The emphasis of the input sub-system is on document analysis including subject indexing, classification and abstracting. In all cases manual methods of analysis are described first and then the discussion centers on the help that automation can provide and the techniques of machine indexing, machine classification, and machine abstracting. The importance of terminology control is also stressed.

3.3.3 Storage Sub-System

The section on the storage sub-system is concerned with the techniques of file organization and the different principles that can be used to organize both the document files and various index or surrogate files. The relationship of the file structure to the equipment--the physical tools and hardware--used to record and store the information is emphasized. The varieties of storage media ranging from library catalog cards, tabulating cards, edge-notched cards, aspect cards, paper tape, magnetic type, drums and disc, and various types of microfilm are described in detail. Mechanized information handling means more than computerization.

3.3.4 Search and Delivery Sub-System

The purpose of input analysis and storage is to provide for efficient search and delivery of the desired documents. The relationship between query analysis and document analysis is stressed while at the same time reviewing the importance of vocabulary control. Various search strategies are described and related to the file structure. Information retrieval does not end with the location of the relevant bibliographic references; it is necessary to deliver the document or a reproduction. The role of mechanization in circulation control, copying, and warehousing is discussed.

3.3.5 Performance Evaluation

A basic tenet in systems analysis and design is that system design should be based upon evaluation of performance. Methods of evaluation (recall, precision, user feedback, and cost-benefit) are mentioned although not described in any great detail. The emphasis is placed upon the need for evaulation and the identification of system and performance variables that can be used in the evaluation procedure. This section emphasizes the philosophy of evaluation rather than the methodology.

3.3.6 Summing Up

The information retrieval systems course covers a great deal of material. In the final week, the aims, procedures and organization of an information system are reviewed, and

the sub-systems, which had been discussed as separate components, are reunited by means of the block diagram.

3.4 LS 240 - INFORMATION SYSTEMS ANALYSIS AND DESIGN

This course is designed to provide an introduction and orientation to the methods and procedures used in the analysis and design of computer-based document storage and retrieval systems for such applications as libraries and industrial information centers. The particular emphasis of the course is on methods, models, and measurement for use in the evaluation of systems. The course content is divided into five sections:

1) Introduction
2) The Process of Systems Analysis
3) Principles of File Organization and Searching
4) Models for Measuring Library Use and Effectiveness
5) Principles of System Evaluation

The textbook used is:

Morse, Philip M. Library Effectiveness: A Systems Approach, the MIT Press, 1968.

The students are required to take an essary type mid-term examination; to participate in a class project requiring the utilization of campus computer facilities, and to write a term paper describing their work in this project.

The mid-term examination covers the material on systems analysis and file organization. The section on modeling is not covered by examination. This portion of the course is mathematically oriented and requires a familiarity with statistical and operations research concepts. Students, other than MSIS degree candidates

are encouraged to take the course. By giving the examination prior to the section on models, they are not put at a disadvantage. Similarily, while the class project does require the use of a computer, students who do not know programming will work together with those who do, to the mutual benefit of both groups.

The class project changes from quarter to quarter. The purpose is to provide experience in evaluating certain design choices. A typical project is the following:

Starting with an ERIC tape of approximately 2000 records, the students are required to:

1) Write a linear file organized by document number;
2) Write an inverted file organized alphabetically by index term;
3) Write a threaded list file of subject headings;
4) Prepare 10 search questions relevant to information contained in the file and using two different search strategies; i.e., high recall and low precision, and high precision, low recall;
5) Search the files, and compare the effectiveness of the different file structures as used separately or in combination.

The term paper, which is a report of the student's participation in the class project, can be part of a team effort; although individual work must be identified. Basic programs will be made available through the instructor.

3.4.1 Introduction

The aims of the course and the requirements are discussed in detail together with the instructor's orientation and his expectations regarding work from the students. Various terms are defined as they will be used in this class.

3.4.2 The Process of Systems Analysis and Design

Five sessions are spent on the process of systems analysis and design. This material is not covered in the textbook nor in any other single source. The various elements that make up a systems design are described as are the procedures for accomplishing these tasks. Special emphasis is given to the responsibilities of management and the design team in carrying out the project planning, analysis and design phases. The techniques of operations research and flow charting procedures are described.

3.4.3 Principles of File Organization and Searching

The structure of the storage and index files that are to be used in the computerized information system are singled out for special study. Systems analysis and design techniques are applied to the problem of how to select a file structure and evaluate its effectiveness. Discussions in this section are directly related to the work in the class project. Other examples of systems applications are given as well.

3.4.4 The Use of Theoretical Models

The systems approach, particularily modeling techniques, is applied to the determination of library effectiveness.

Using Morse's text, we examine the use of probability and poisson distributions, of queuing and Markov models, to estimations of library users, circulation and book use.

3.4.5 Principles of Systems Evaluation

The final week of the course is spent integrating the various ideas that had been discussed and their relationship to the concepts and techniques of systems analysis.

3.5 LS 249 - SEMINAR IN INFORMATION SCIENCE

This seminar course provides an opportunity to examine and discuss various research topics in information science. It is intended primarily for students who are candidates for the MSIS degree and who will use this course as preparation for the selection of a thesis topic. In keeping with this main objective the seminar has three complementary aims:

1) to provide information about appropriate research procedures and illustrations of their use;
2) to provide a broad overview of a wide range of research topics in information science; and
3) to provide an opportunity to do an in-depth study of a specific research problem.

The textbooks used are:

1) Borko, H. (Editor). Automated Language Processing, first corrected printing, John Wiley and Sons, N. Y., 1968.
2) Cuadra, C. (Editor). Annual Review of Information Sciece and Technology, Encyclopedia Britannica, Inc., Chicago, Illinois, the latest volume.

There are no examinations; the students are graded on their participation in the seminar discussions and on the basis of a term paper. The term paper consists of a state-of-the-art report on a research topic and includes suggestions for further research needed to clarify specific problem areas. The paper must also contain an automated bibliography of the relevant literature.

3.5.1 Research Techniques in Information Science

During the first few lectures the instructor will discuss the basic statistic, syntactic and semantic techniques of processing and analyzing language by computer. We will also examine current journals and survey the research typically encountered in information science.

3.5.2 Survey of Information Science Research

Each student will select a chapter in the current Annual Review of Information Science and Technology. He will study the selected topic, read some of the more important referenced material, and make an oral report to the class of that current state-of-the-art in that area. With each student reporting on a chapter, and all participating in the class discussion, a broad overview of current research in information science should result.

3.5.3 In-Depth Study

As soon as possible, each student will select a research topic of particular interest and prepare a term paper. With the aid of the two textbooks and current journal literature, he will review the research that had been done in this area

and the pros and cons of the methods that had been used. He will then plan a research design stating: the topic, the purpose, the hypotheses to be tested, and the methodology to be used. A very significant portion of the term paper will be devoted to the preparation of a reasonably comprehensive annotated bibliography.

3.5.4 Reports

During the final portion of the quarter, students will discuss their term papers.

4. STRUCTURE OF PROGRAM SYSTEMS ANALYSIS

The purpose of the program is two-fold: first, to provide the student with the technical tools for information systems design and second, to bring him to the point of independent, professional work. As a result, the program divides naturally into two chronological parts, with an entracte.

First Academic Year

The first year is devoted to providing the student with technical tools for systems work. Some of them are drawn from fields outside of information systems work--managerial accounting and operations research from business administration, statistics from mathematics, systems design techniques from engineering. Some of them are directly related to information systems work and are taught by the library school--cataloging and classification, bibliography and reference, library and information center management, information retreival and data base management.

These diverse courses are finally brought to a focus in the course on Information Systems Analysis and Design (LS 240). It occupies a

crucial role in relating the various tools to the specific problems in information systems work. From it, the student can move on into independent study, leading him into truly professional work.

Entracte. The summer between the first and second year provides an opportunity for a period of actual experience, through internship in one or another information environment--a special library of one kind or another, an information center, a research enterprise, etc. In this way, the theory can be seen from the viewpoint of practice and the problems, both theoretical and pragmatic, seen with fresh eyes.

Second Academic Year

The second year is devoted to independent study supported by course work related to it. First, the student must formulate his proposal for independent work. The Seminar in Information Science (LS 249) provides the formal structure within which he does so. The result of his work in it must be an acceptable thesis proposal, including a definition of the problem of concern, a review of the present state of knowledge, a tentative organization of the work to be done, and a detailed time schedule for the ensuing six months. The proposal serves a central pedagogical function, and the time schedule perhaps the most important part of it. It serves the student as a measure of what he can (or cannot) accomplish in an allotted time, and thus teaches one of the most important aspects of professional work--a proper measure of one's capacity.

The final six months of independent work are then the culmination of the program--the demonstration that the student can formulate a task of reasonable magnitude, apply technical tools to its solution, and complete the task within his own determined time schedule.